DARK ENERGY SURVEY

Plans for Calibration of Early DES Data and Full Calibration

(See DES-doc#6584: Plan for Calibration of the DES in the Early Years)

Douglas L. Tucker

DES DOE-NSF Review

23-24 April 2013

Outline:

1. Basic DES 5-Year Calibrations Strategy
2. Challenges for SV Calibration
3. Challenges and Plans for DES Years 1 & 2
4. Ongoing Work

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Basic DES Observing Strategy

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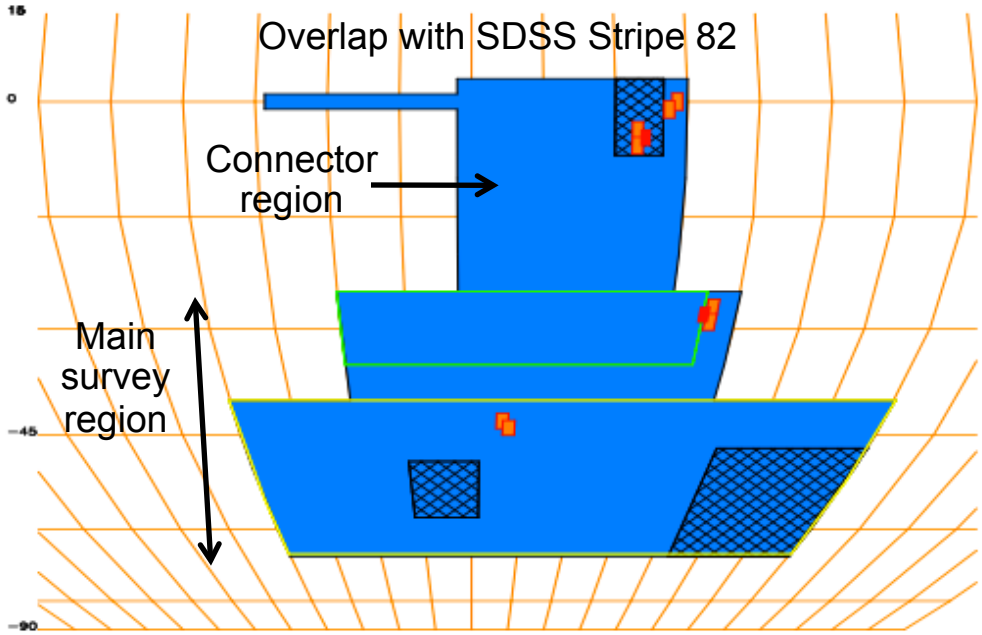
Observing Strategy

- 100 sec exposures (nominally)
- 2 filters per pointing (typically)
  - *gr* in dark time
  - *izY* in bright time
- Multiple overlapping tilings (layers) to optimize photometric calibrations
- 2 survey tilings/filter/year
- Photometric Requirements (5-year)
  - All-sky internal: 2% rms (Goal: 1% rms)
  - Absolute Color: 0.5% (*g-r*, *r-i*, *i-z*); 1% (*z-Y*) [averaged over 100 objects scattered over FP]
  - Absolute Flux: 0.5% in *i*-band (relative to BD+17 4708)
- 5-year depth (co-added): ~24th mag for galaxies in i-band

Survey Area

Credit: J. Annis



Total Area: 5000 sq deg

Aside: Results from the First Night of SV

(Residuals of Nightly Standard Star Solution in g-band for Nov 1)

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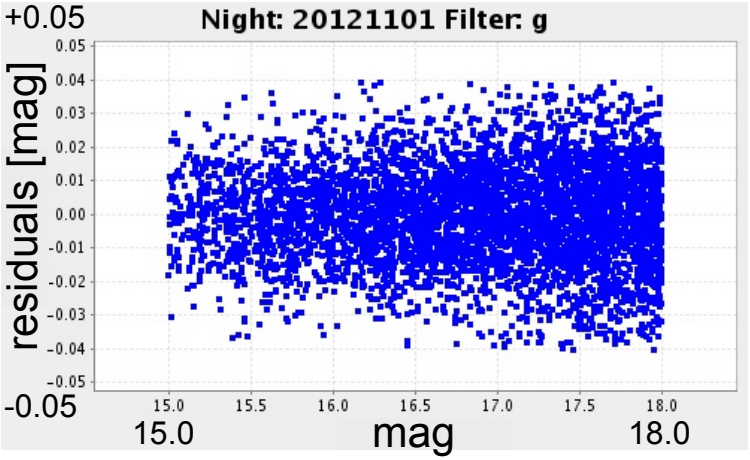
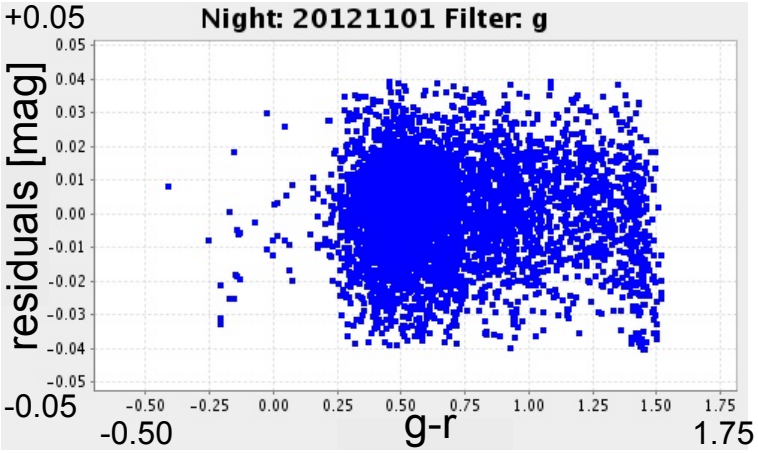
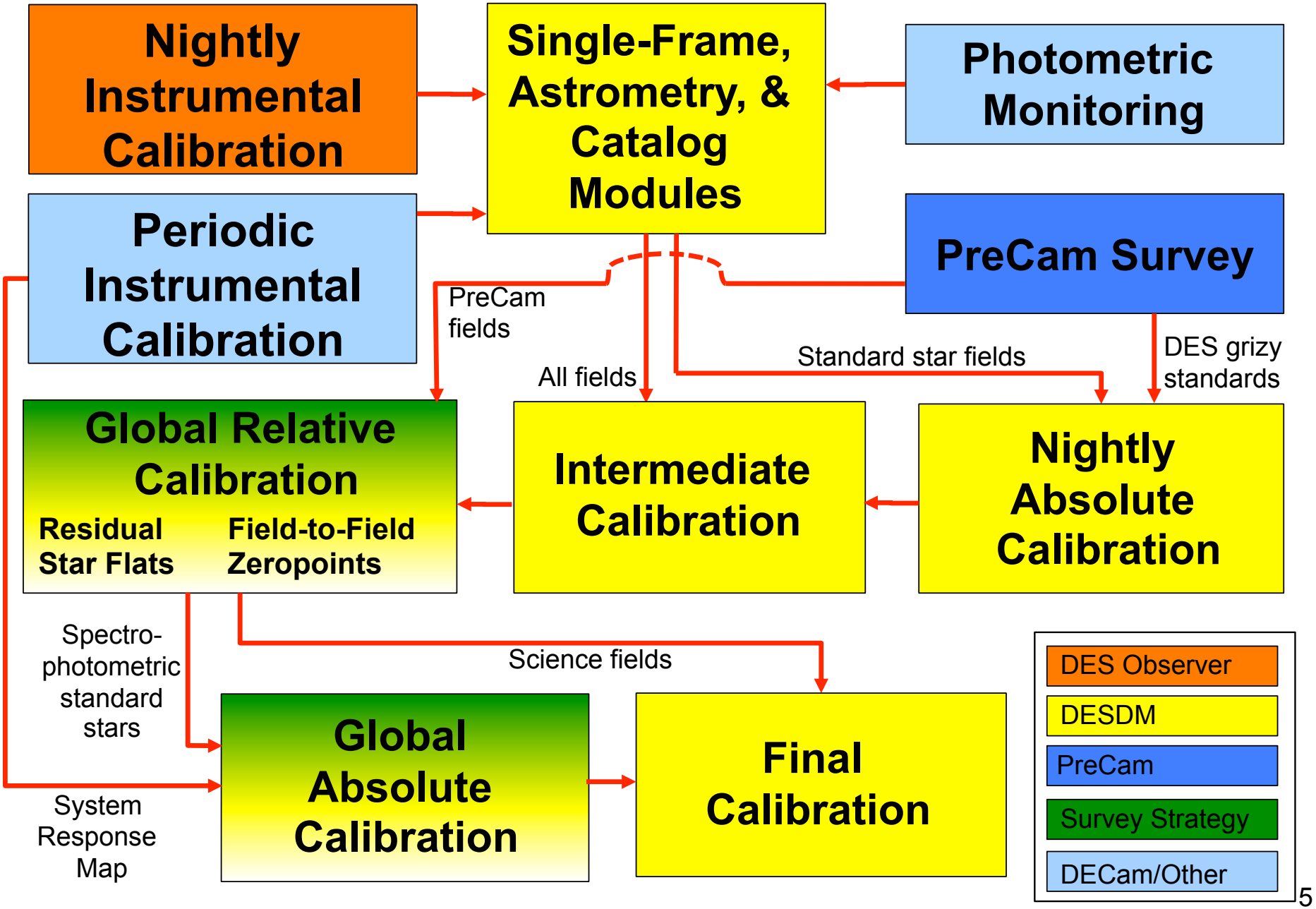
RMS: 1.4%!

(includes internal and absolute calibration)





DES Photometric Calibrations Flow Diagram (v4.1)



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DES Calibrations Plan in 6 Points

1. Instrumental Calibration (Nightly & Periodic): Create biases, dome flats, linearity curves, cross-talk coefficients, system response maps.
2. Photometric Monitoring: Monitor sky conditions with 10μm All-Sky Cloud Camera and the GPS and atmCam atmospheric transmission monitors.
3. PreCam Survey: Create a network of calibrated DES *grizy* standard stars for use in nightly calibrations and in DES Global Relative Calibrations.
4. Nightly and Intermediate Calibrations: Observe standard star fields with DECam during evening and morning twilight and at least once in the middle of the night; fit photometric equation; apply the results to the data.
5. Global Relative Calibrations: Use the extensive overlaps between exposures over multiple tilings to tie together the DES photometry onto an internally consistent system across the entire DES footprint.
6. Global Absolute Calibrations: Use DECam observations of spectro-photometric standards in combination with measurements of the full DECam system response map to tie the DES photometry onto an AB magnitude system.

1. Instrumental Calibration:
An Example of Periodic Instr. Calibration

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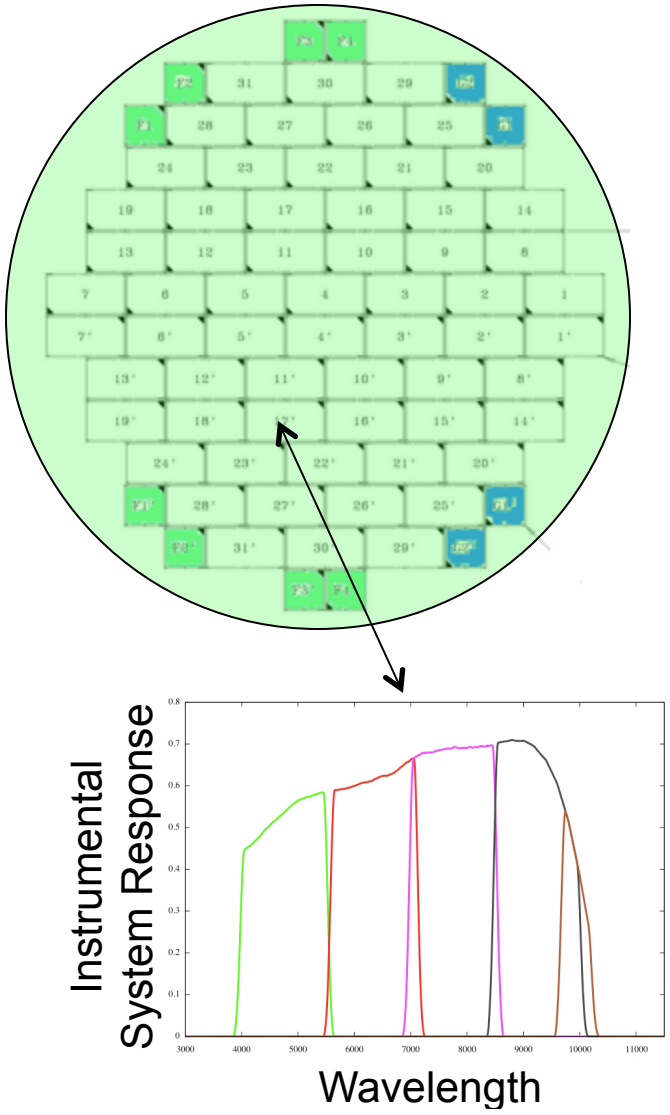

DECal System Response Map

(See William Wester's talk.)

- The shape of the system response varies as a function of position on the focal plane (the filters are not 100% homogeneous).
- Therefore, the system response map from DECal will be important for Global Absolute Calibration, catalog and image co-adds, enhanced calibration of specific classes of astronomical objects, and system performance tracking over time.
- This is a typically once-a-month calibration, taking several hours to measure all 5 DES filters (on a cloudy night).

2. Photometric Monitoring:
The 10 micron All-Sky Camera

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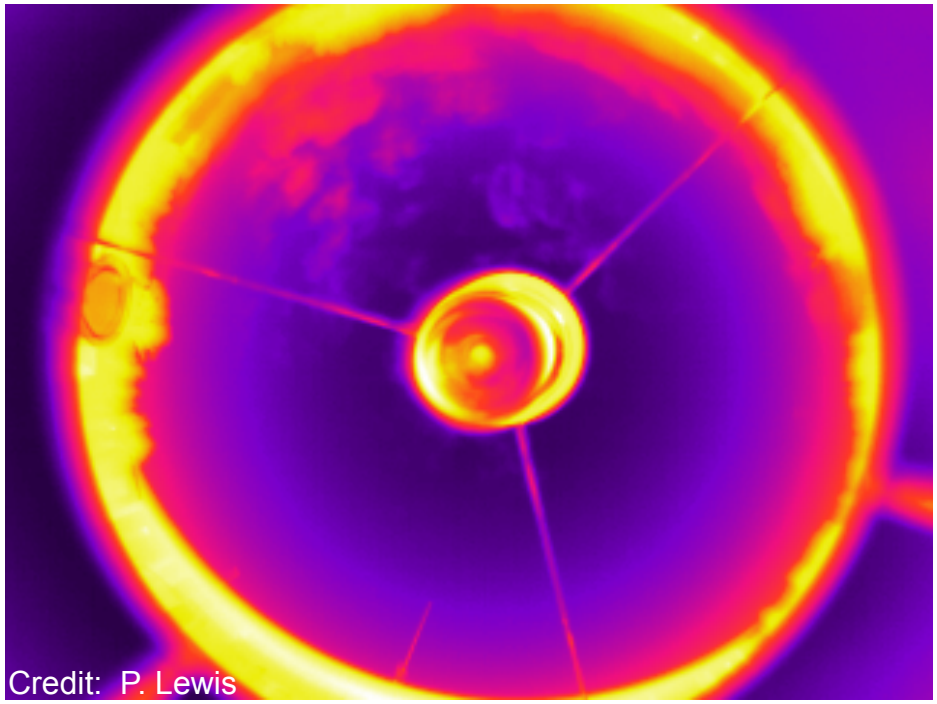
10 micron All-Sky Camera

- Provides real-time estimates of sky conditions for survey strategy
- Provides a measure of the photometric quality of an image for off-line processing
- Detects even light cirrus under a full range of moon phases (no moon to full moon)



RASICAM image: light cirrus

The DES Camera: "RASICAM"

- "Radiometric All-Sky Infrared CAMera"
- Web interface for observers
- Photometricity flags passed to each exposures FITS header via SISPI for use by DESDM
  - Nightly calibrations
  - Global relative calibrations

(Nightly RASICAM movies archived on YouTube)

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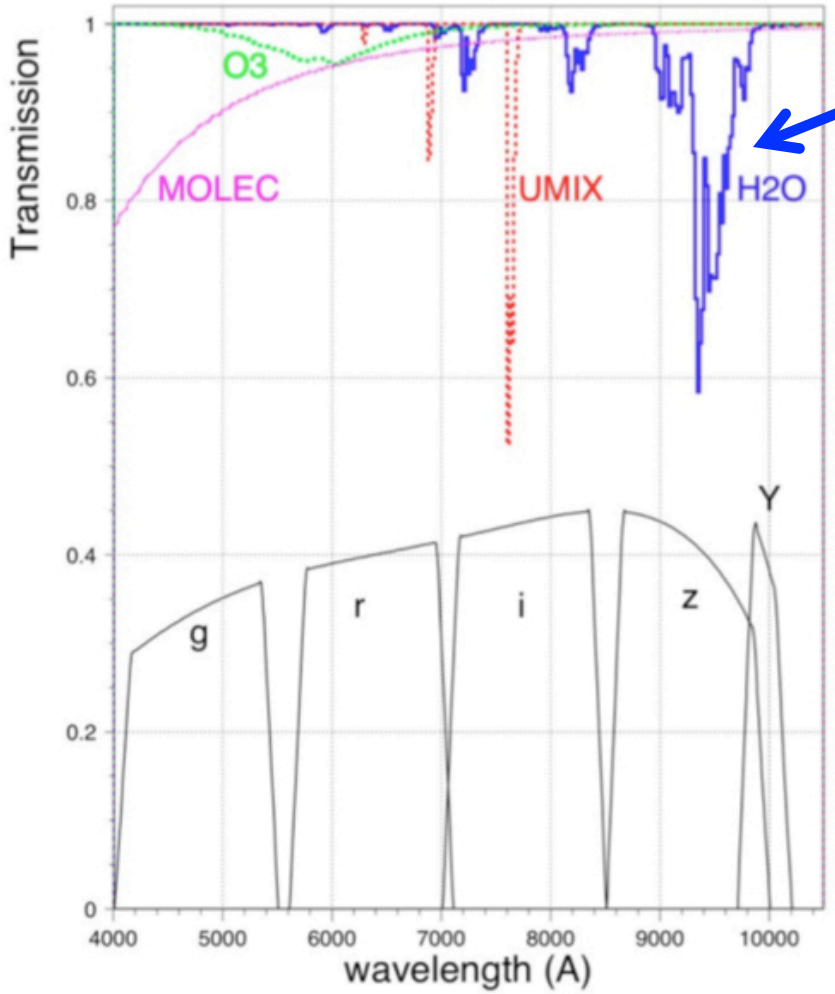
2. Photometric Monitoring: GPS Precipitable H_20 Vapor Monitor



- **Why?** To correct the z-band calibration for changes in atmospheric absorption due to water vapor.
- **How?** The index of refraction of H_20 induces a time delay (n=1.3 for optical but n≈6 for radio). The H_20 delay is the actual time minus the calculated "dry" time. Estimated precision is 1mm of Precipitable Water Vapor (PWV).
- **When?** Now. The GPS receiver & antenna was installed on the CTIO-1.5m's balcony on Nov. 6, 2012. The system is inexpensive (< US$10K) and completely automated. Suominet processes the data and posts the data to the web.

See Rick Kessler's talk.

2. Photometric Monitoring:
The aTmCam Atmospheric Monitor
(pending)

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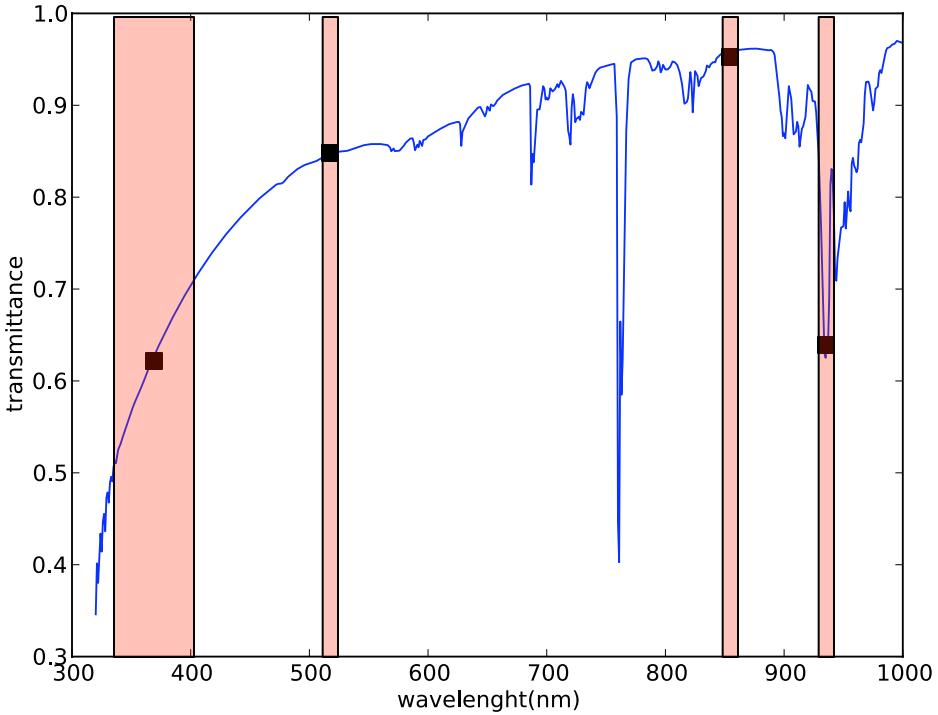
See Ting Li's talk.



TAMU Prototype

Giant 8-inch binoculars

Requires a decision from DES & CTIO whether to install a permanent aTmCam.

3. The PreCam Survey: Overview

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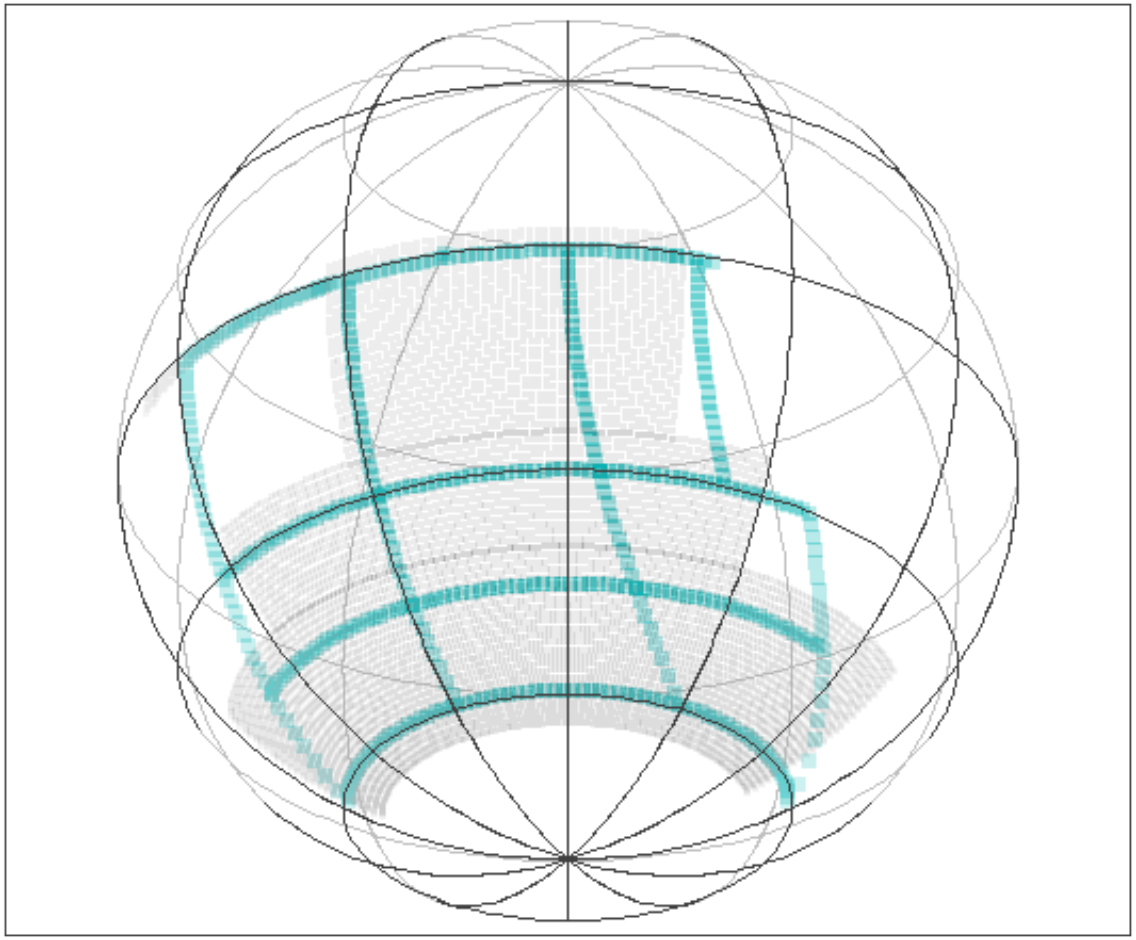
PreCam Survey: a quick, bright *grizy* survey in the DES footprint using a 4kx4k camera composed of DECam CCDs – the "PreCam" – mounted on the University of Michigan Dept. of Astronomy's Curtis-Schmidt Telescope at CTIO.

Observations took place in Aug/Sep 2010 and Nov 2010 - Jan 2011.

3. The PreCam Survey:
The Survey Strategy as Planned

DARK ENERGY SURVEY



- ~600 sq deg (12% DES area)
- ≈30° grid pattern
- 10 tilings in each filter (*g*, *r*, *i*, *z*, *Y*)
- Calibration stars down to r≈17.8 (S/N=50), or about 1.5 mag fainter than nominal saturation limit of a typical DES wide-field survey science exposure

- Useful for nightly calibrations, early year calibrations, and global calibrations.

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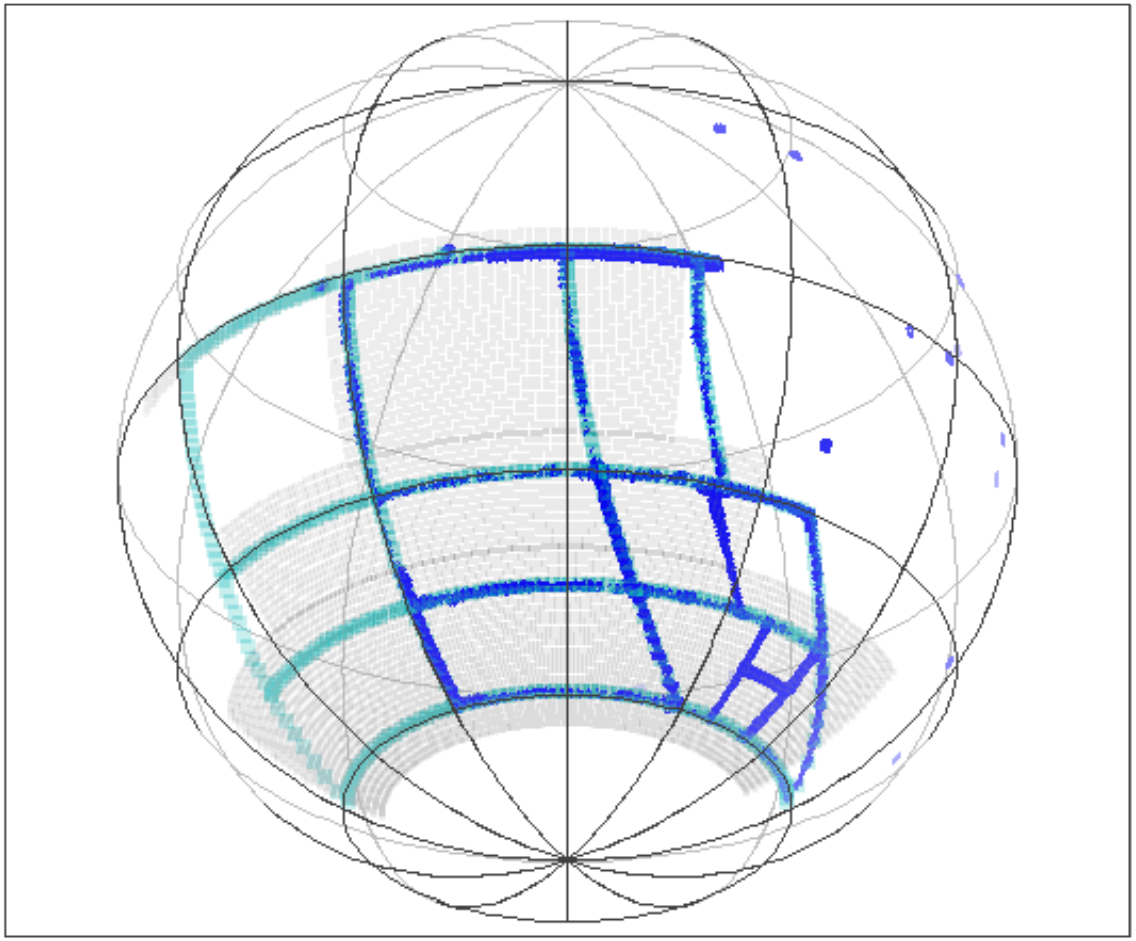
3. The PreCam Survey:
The Survey as Currently Stands

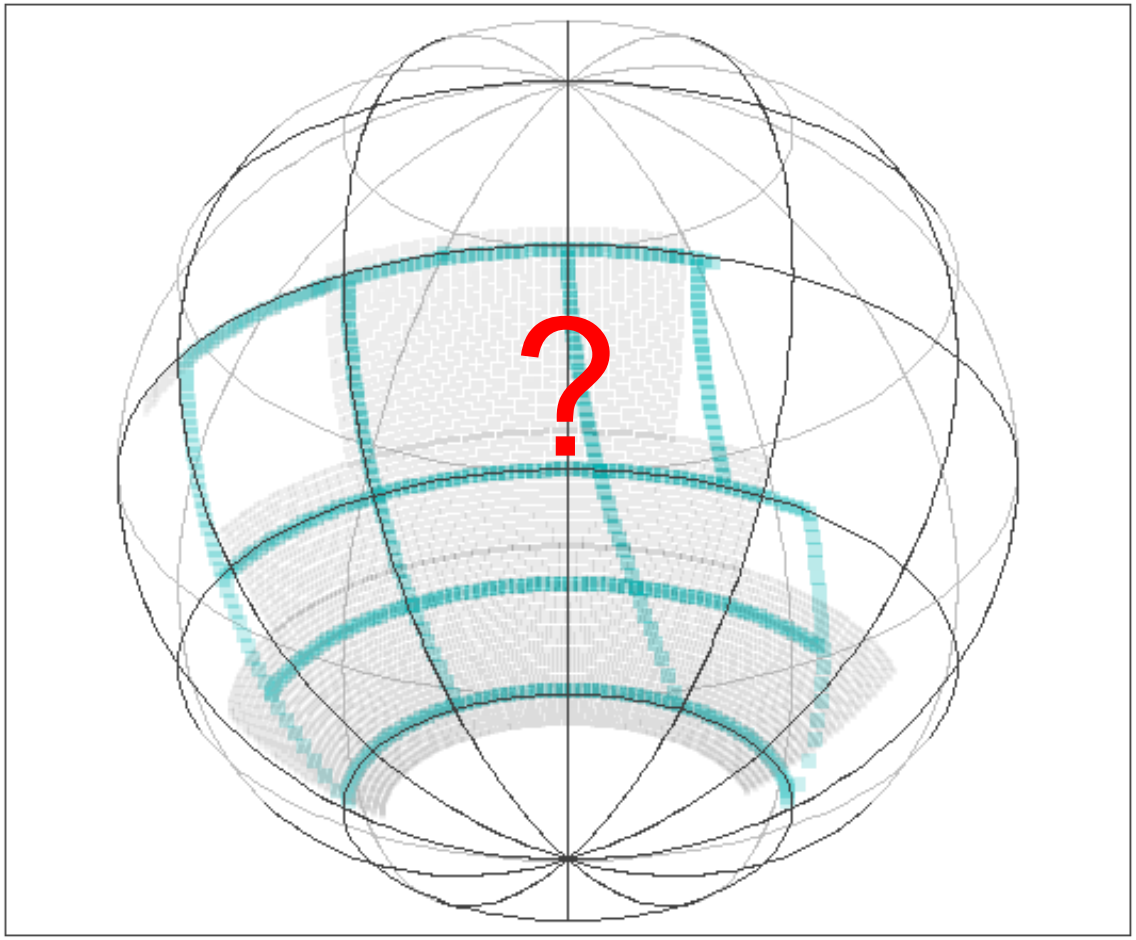


- ~67% complete in g,r,i
  ~5% complete in z,Y
- ≈30° grid pattern
- ~5 tilings in each filter (*g*, *r*, *i*, *z*, *Y*)
- Calibration stars down to r≈17 (0.01 mag rms photometry), or about 1 mag fainter than nominal saturation limit of a typical DES wide-field survey science exposure

- Kuehn et al. 2013, PASP, in press (arXiv:1208.0865); Allam et al., in prep.

3. The PreCam Survey:
The Survey in the Future

DARK ENERGY SURVEY



- Probably would need another 100 nights to complete PreCam Survey as originally envisioned.
- Good infrastructure task for students and postdocs seeking data rights and/or Builder status.
- Calibration group is preparing a proposal for DES management for DES support to continue PreCam ("PreCam 2").

4. Nightly/Intermediate Calibrations: Standard Stars for DES

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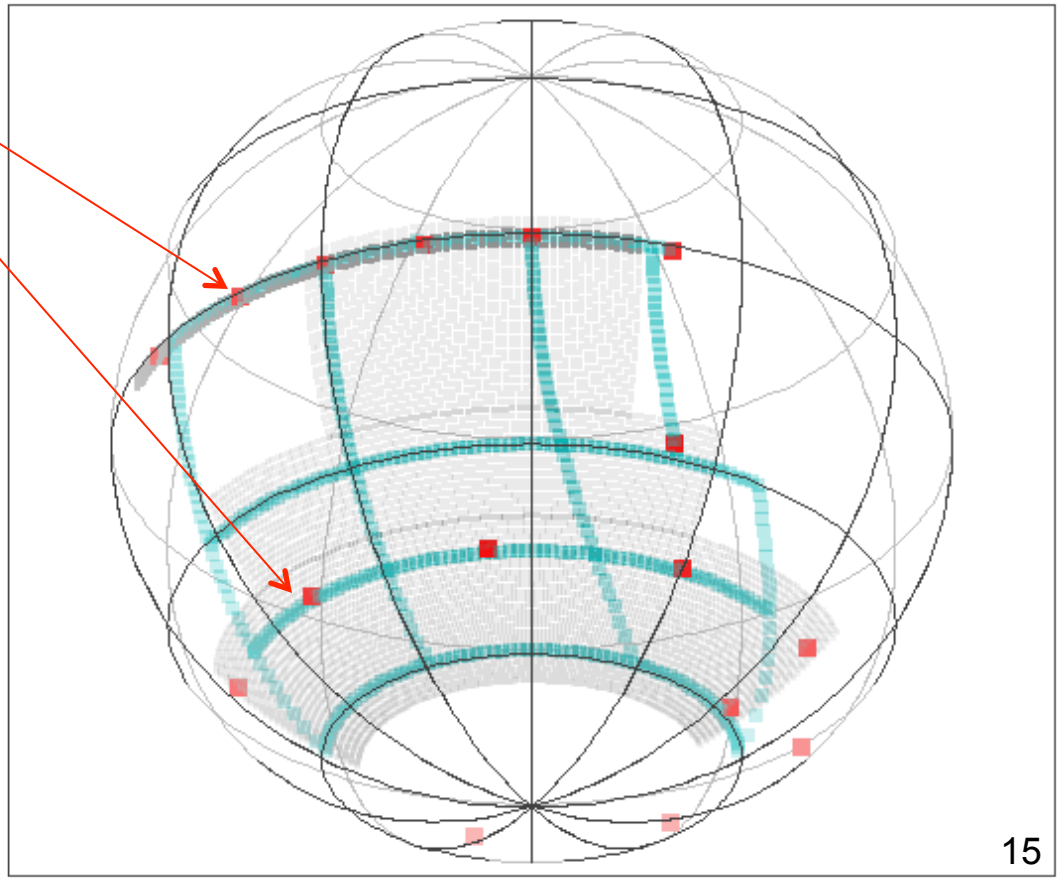
Photometric Equation: $m_{inst} - m_{std} = a_n + b_n \times (stdColor - stdColor_0) + kX$

Nightly standard star fields drawn primarily from a subset of the following:

- SDSS Stripe 82 fields (supplemented by UKIDSS LAS Y-band data)
- Southern *u'g'r'i'z'* standard star fields

Furthermore, PreCam fields will typically be crossed serendipitously numerous times throughout a night during the course of standard DES operations, further reducing the need for dedicated standard star observations in the middle of the night.



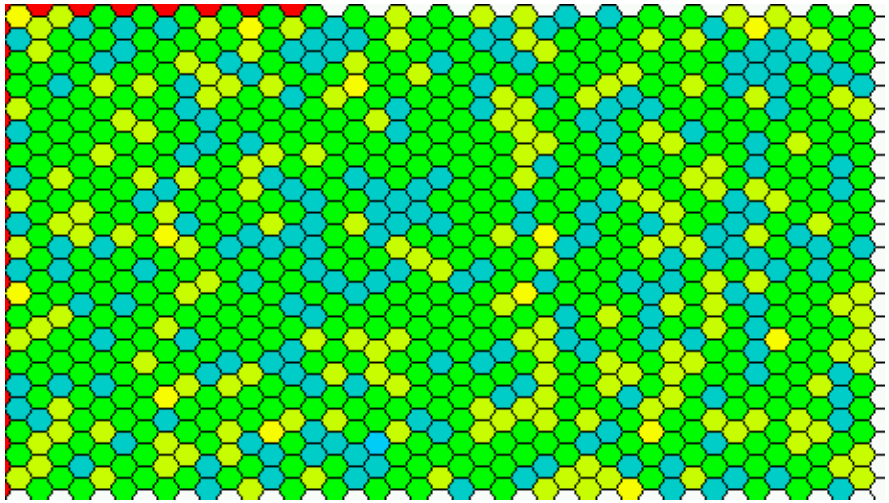
5. Global Relative Calibrations: The Need and The Strategy

DARK ENERGY SURVEY

We want to remove field-to-field zeropoint offsets to achieve a uniformly "flat" all-sky relative calibration of the full DES survey, but…

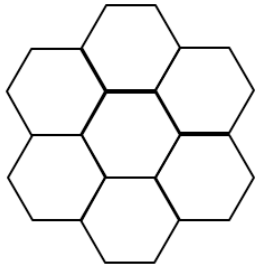
DES will not always observe under truly photometric conditions…

…and, even under photometric conditions, zeropoints can vary by 1-2% rms field-to-field.

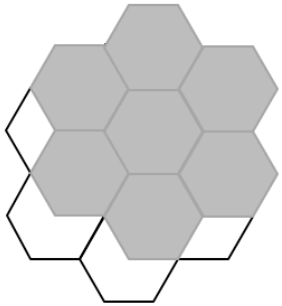


scaling bar is –0.20 mags to +0.20 mags

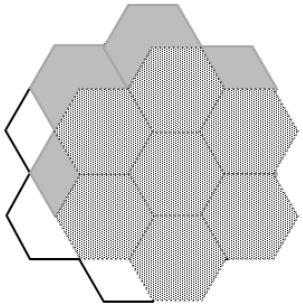
1 tiling



2 tilings



3 tilings



The solution: multiple tilings of the survey area, with large offsets between tilings.

We cover the sky twice per year per filter. It takes ~ 1700 hexes to tile the whole survey area.

6. Global Absolute Calibrations: Basic Method

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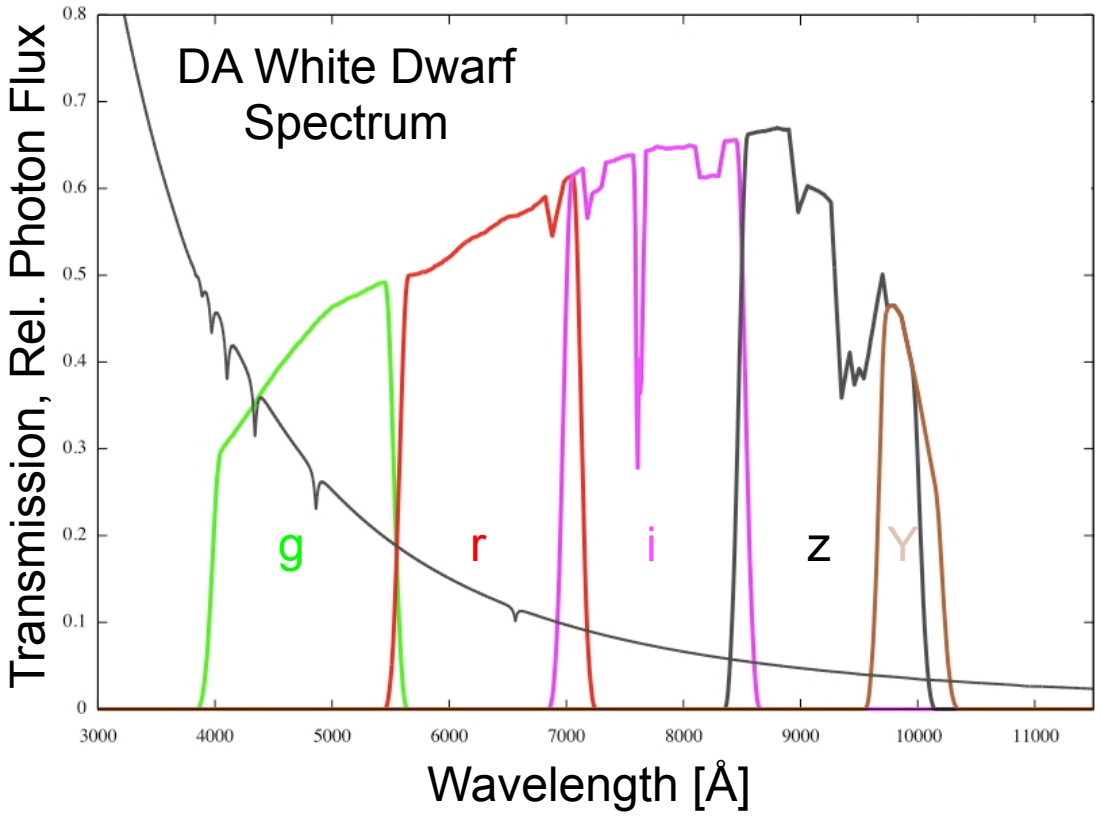
- Compare the synthetic magnitudes to the measured magnitudes of one or more spectrophotometric standard stars observed by the DECam.

- The differences are the zeropoint offsets needed to tie the DES mags to an absolute flux in physical units (e.g., ergs s^{-1} cm^{-2} $Å^{-1}$).

- Absolute calibration requires accurately measured total system response for each filter passband as well as one or more well calibrated spectrophotometric standard stars.



- Plan: establish a "Golden Sample" of 30-100 well-calibrated DA white dwarfs within the DES footprint (J. Allyn Smith, William Wester).

Addendum: Calibrating Early Data with the Stellar Locus Regression (SLR) Method

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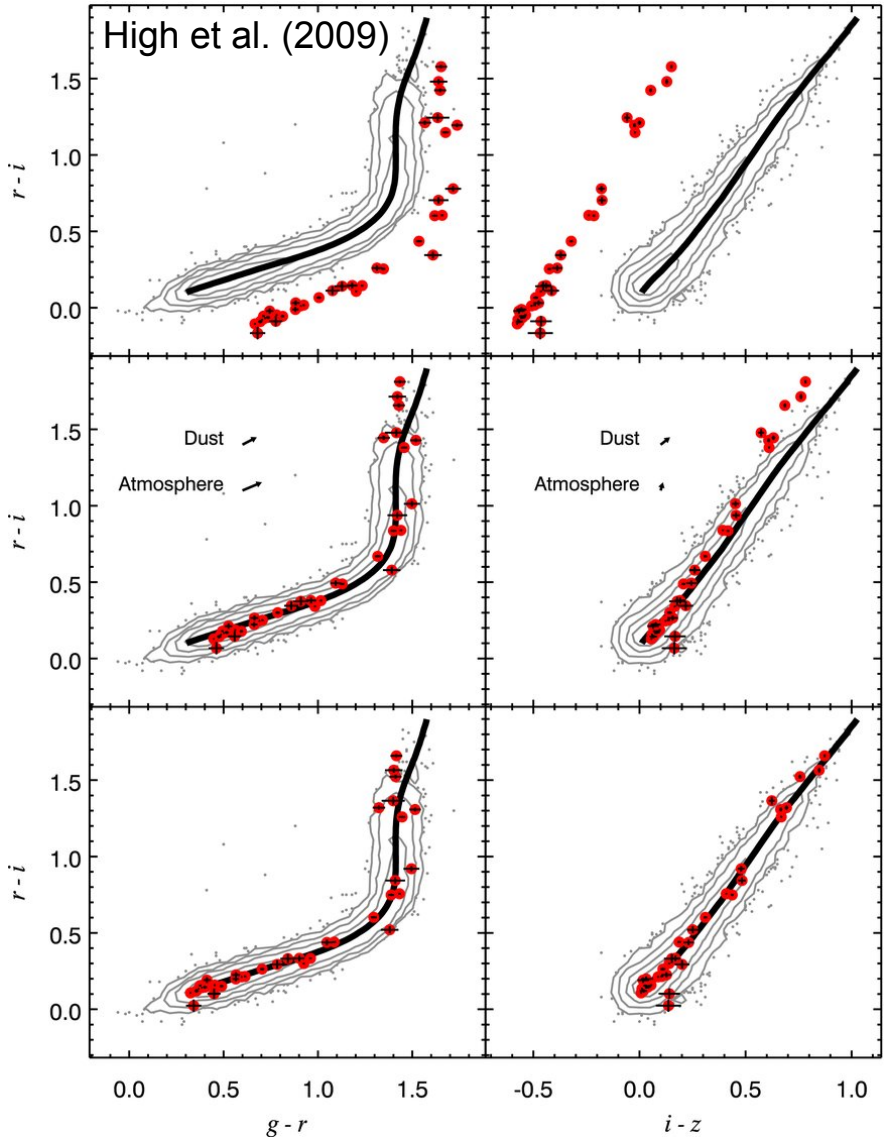
- In the DES, there is a strong philosophical legacy from SDSS to use the stellar locus primarily as a quality assurance check on the photometry (e.g., Ivezic et al. 2004).

- That said, especially in the first year or two, it will be hard to obtain good calibrations for DES.

- Therefore, we are looking into using the SLR method of High et al. (2009), as implemented by Bob Armstrong of the DESDM team, to help with calibrations in the early years. Some of the SWGs have already used SLR on SV data.



DARK ENERGY
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Challenges for SV Calibration

Photometric Goals for SV

- All-sky internal: 3% rms
- Absolute Color: 3% (*g*-*r*, *r*-*i*, *i*-*z*); 4% (*z*-*Y*)
- Absolute Flux: 3% in *i*-band (relative to BD+17 4708)

Photometric Requirements (5-year)

- All-sky internal: 2% rms (Goal: 1% rms)
- Absolute Color: 0.5% (*g*-*r*, *r*-*i*, *i*-*z*); 1% (*z*-*Y*) [averaged over 100 objects scattered over FP]
- Absolute Flux: 0.5% in *i*-band (relative to BD+17 4708)

Challenges for SV Calibration

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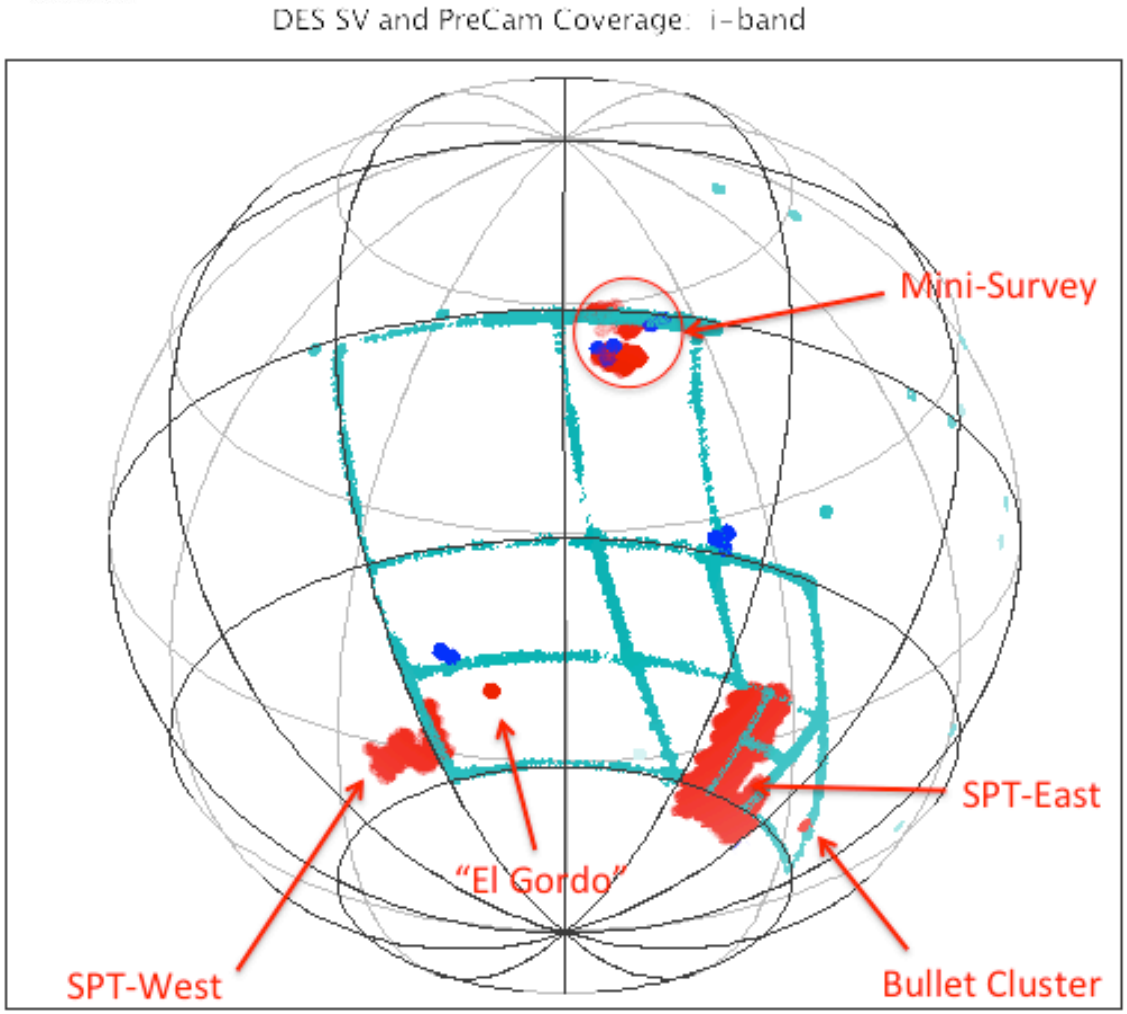

- DECam "natural" system not yet fully defined.
- Disconnected "islands" of data to be connected.
- Uncompleted PreCam.
- Relative lack of Y-band standards.
- DA WD "Golden Sample" still being constructed.
- Improvements to non-linearity corrections, pupil ghost measurements, etc., still in progress.

But no big "gotchas" – recall Slide 4.

Global Calibration Module
Updated Calibration for SV "Y1C1" SPT-E
(22 April 2013)

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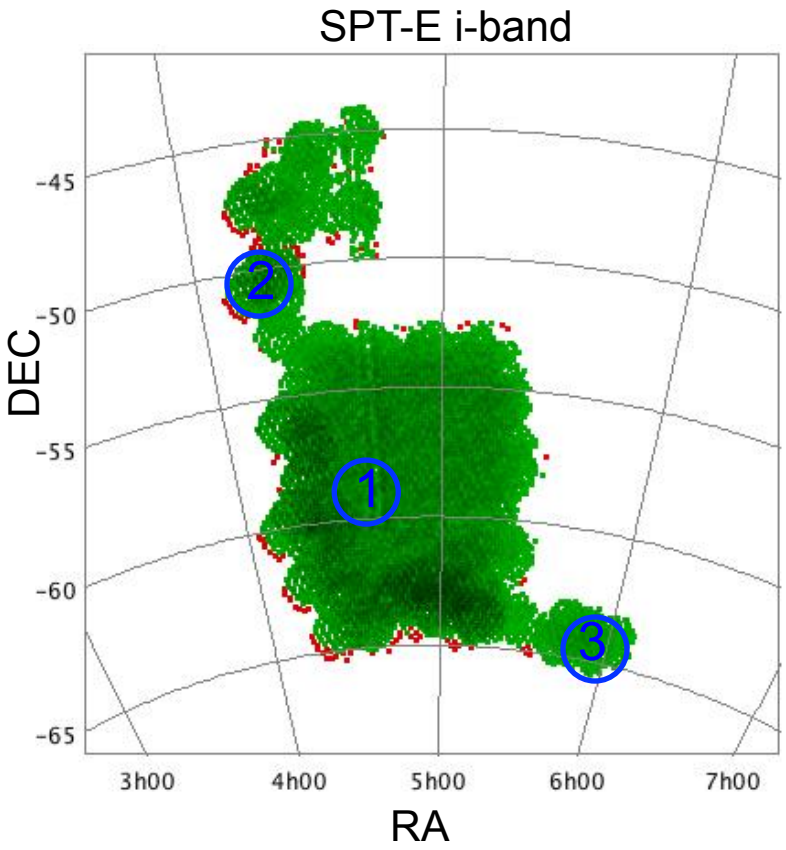

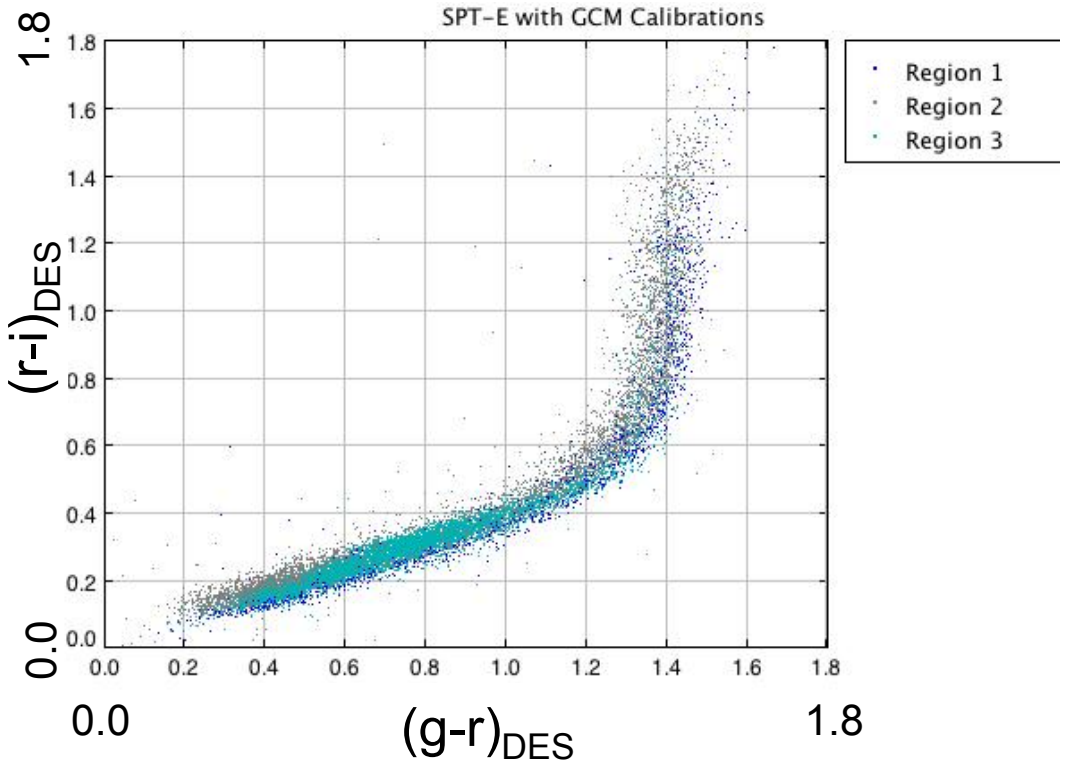

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Challenges and Plans for DES Years 1 & 2

DARK ENERGY SURVEY

Photometric Goals for DES Year 1

- All-sky internal: 3% rms
- Absolute Color: 3% (*g*-*r*, *r*-*i*, *i*-*z*); 4% (*z*-*Y*)
- Absolute Flux: 3% in *i*-band (relative to BD+17 4708)

Photometric Goals for DES Year 2

- All-sky internal: 2% rms
- Absolute Color: 2% (*g*-*r*, *r*-*i*, *i*-*z*); 3% (*z*-*Y*)
- Absolute Flux: 2% in *i*-band (relative to BD+17 4708)

Photometric Requirements (5-year)

- All-sky internal: 2% rms (Goal: 1% rms)
- Absolute Color: 0.5% (*g*-*r*, *r*-*i*, *i*-*z*); 1% (*z*-*Y*) [averaged over 100 objects scattered over FP]
- Absolute Flux: 0.5% in *i*-band (relative to BD+17 4708)

Challenges and Plans for DES Years 1 & 2

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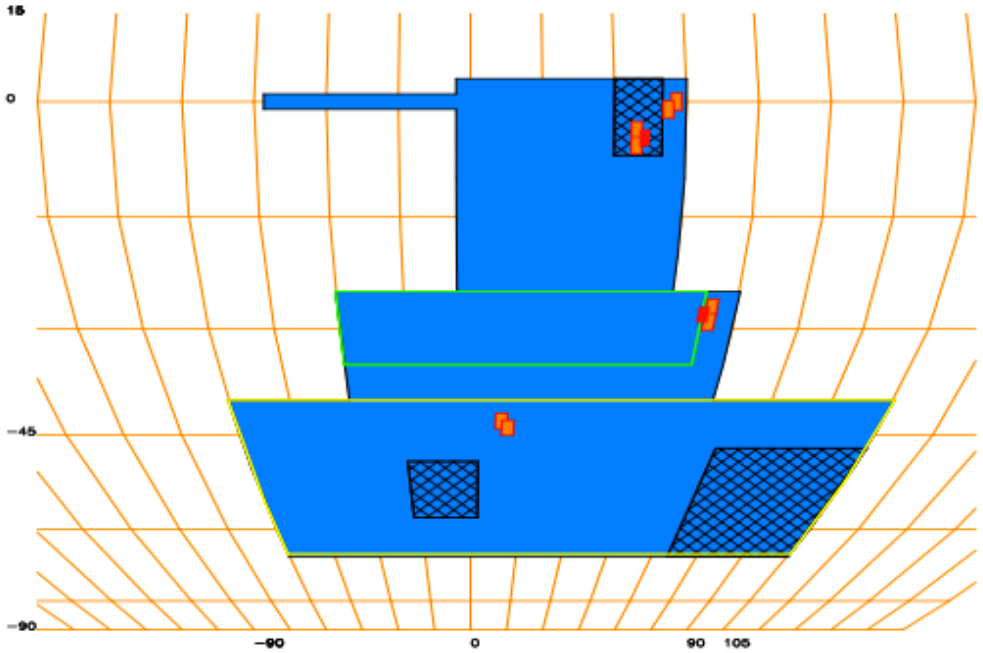

- Only a few tilings per filter by end of each of these Years.
  - Use RASICAM outputs to flag non-photometric images
  - Use PreCam to tie DES photometry to rigid grid of Precam g,r,i standards
  - If necessary, use SLR method
- Uncompleted PreCam.
  - Start a PreCam Season 2?
- DA WD “Golden Sample” still being constructed.
  - Use a “Bronze” or “Silver” sample from partially completed “Golden Sample”
- Continued relative lack of Y-band standards.
  - Supplement with PanSTARRs y-band standards (Magnier et al. 2013, ApJS, 205, 20)

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DARK ENERGY SURVEY

Ongoing Work

(apologies to those whose names I missed!)

- Pupil Ghost and Star Flat Measurements: Annis, Armstrong, Bauer, Bernstein, Desai, Foust, Gruendl, Lin, Nord, Regnault, Tucker, Wester, Vikram, Yanny (in association with SV and DESDM teams)
- DES Natural System/SDSS->DES Transformations: Allam, Bauer, Bechtol, Li, Marshall, Rheault, Tucker, Wester
- Instrumental Response: DePoy, James, Marshall, Rheault, Wester
- Sky Monitoring: Lewis, Reil (RASICAM); Kessler (GPS); DePoy, Li, Marshall, Rheault (atmCam)
- Standard Star Field Calibration: Allam, Smith, Tucker, Vikram
- PreCam2: Allam, Annis, Burke, Kuehn, Kuhlmann, Spinka, Tucker
- CCD Non-Linearities: Butner, Estrada, Lin, Martini, Vikram, Yanny (in association with SV team)
- Stellar Locus Regression: Armstrong, Desai, Bechtol, Huff
- DA White Dwarf Bronze/Silver/Golden Sample: Allam, Smith (co-lead), Tucker, Wester (co-lead)

DARK ENERGY
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Summary and Conclusions

The calibrations effort is on track for the start of DES Operations on September 1, 2013.

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Extra Slides

DES, PreCam, and Pan-STARRS 1 Photometric Reference Ladder (R12.01)

(Magnier et al. 2013, ApJS, 205, 20)

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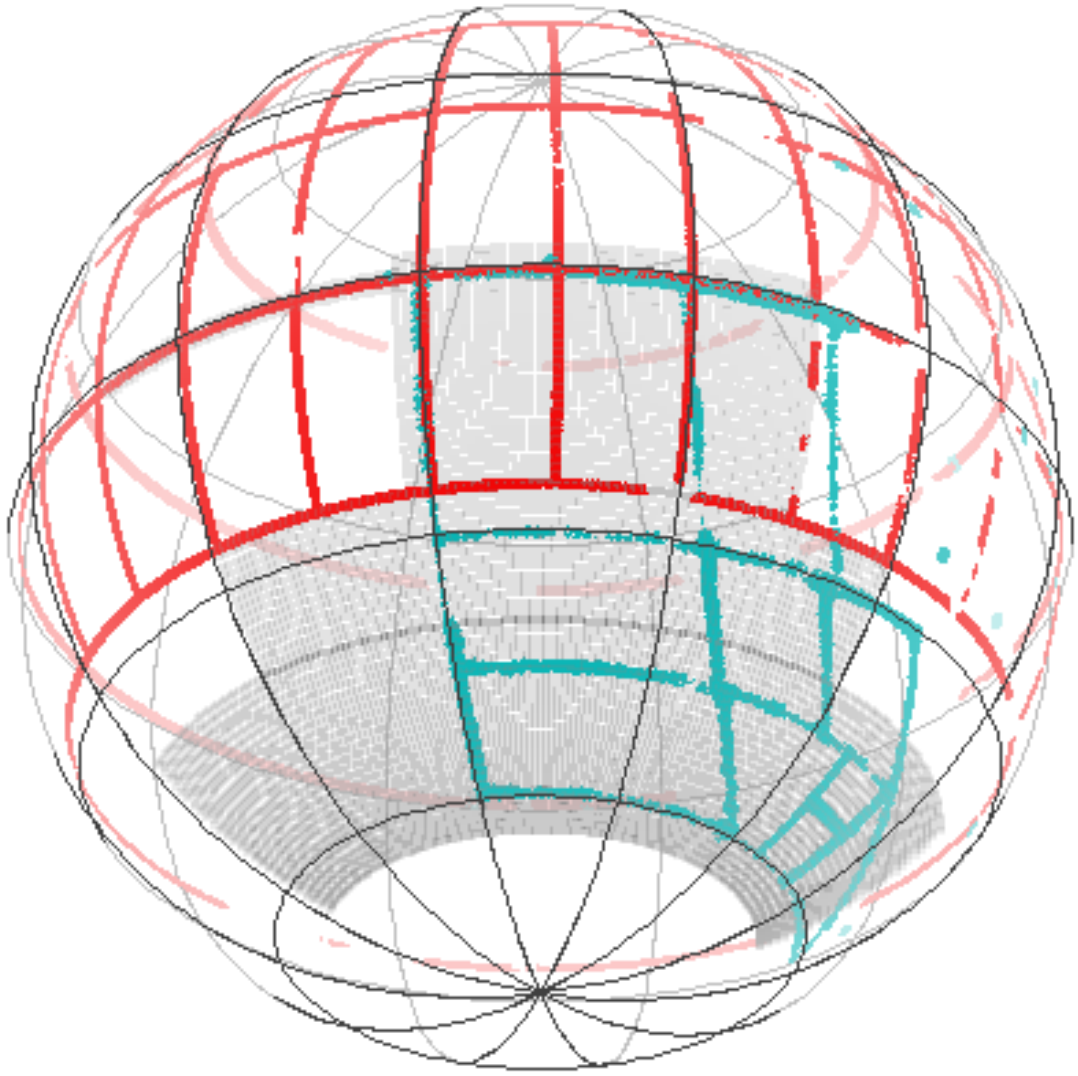
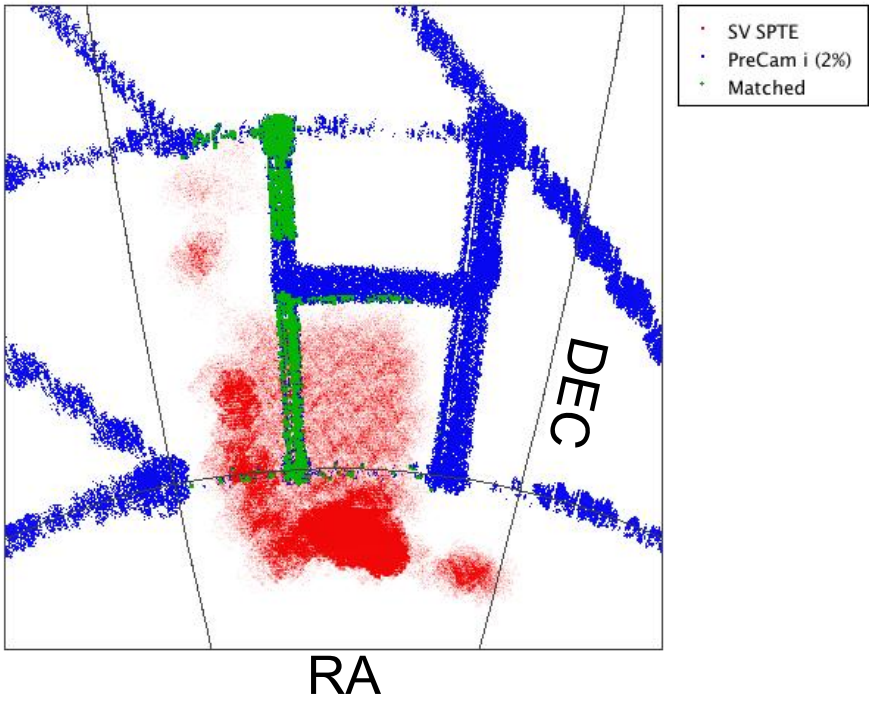
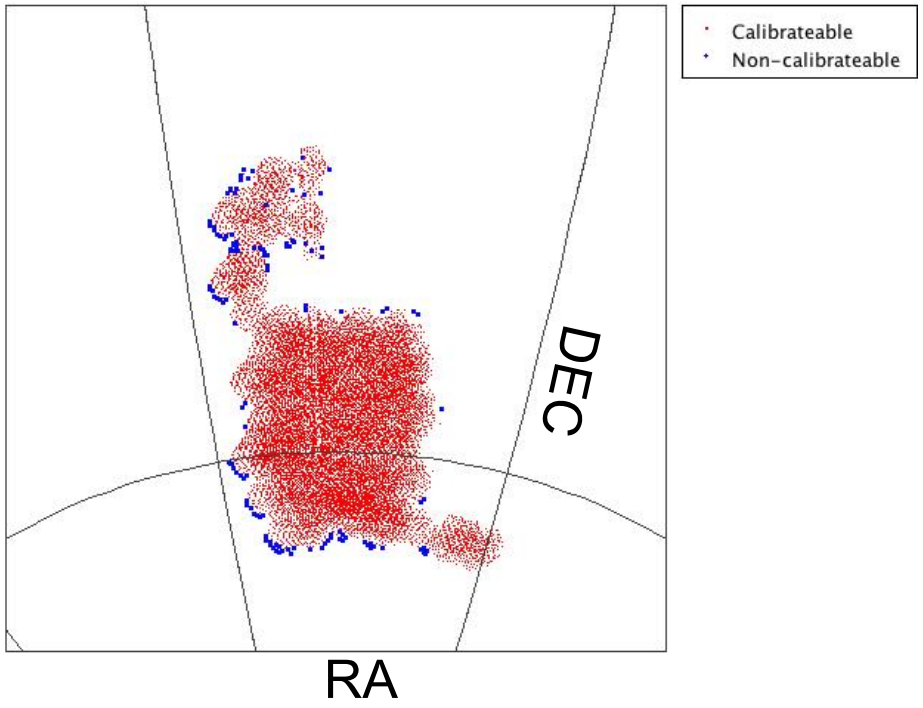


DES SV SPT-E, PreCam, and GCM

DARK ENERGY SURVEY

DESDM FinalCut Processing: i-band





Global Calibration Module Photometry Results for SPT-E: 0.0067 mag RMS

Calibration Responses to May 2012 Review: Photometry Plan

#	Recommendations	Assigned to	Status/Action	Date*
8	Craft a separate plan on how photometry will be handled for the DES, e.g., primary mirror cleanliness and recoating frequency, filter characterization monitoring, on-sky photometric calibrations, etc. (See also DES-doc#6584: "Plan for Calibration of the DES in the Early Years")	DePoy, Tucker, Walker	The standard Blanco primary cleaning schedule -- cleaning every 2 weeks with CO2 snow, washing every 6 months, and re-aluminizing every c. 5 years -- should be sufficient for maintaining the photometric and S/N stability of the DES. The system throughput will be monitored by following the photometric zeropoints and instrumental color terms obtained from observations of standard star fields each night and comparing to their initial values at the start of DES operations. A change in zeropoints of 5% (as observed under photometric conditions) from their initial values will trigger discussion with CTIO for the need for a special cleaning. The DECal system will perform a full wavelength scan of the filters roughly once a month. These data (as are the results from the nightly photometric solution) will be stored in the DESDM database, permitting tracking of changes. If the color terms from the nightly photometric solution or the synthetic color terms from the monthly DECal scan change by more than 30%(?) from their initial values, this will trigger discussion with CTIO for a plan of action. SV plans include monitoring of response stability at least over the first month of Commissioning + SV. Should be able to create a suite of "regression tests" from SV code/data. SV tests included monitoring of response stability during the SV period. A suite of "regression tests" for monitoring the response stability is planned based upon the results of the SV tests.	Completed: August 2, 2012

Calibration Responses to May 2012 Review: QA Outputs

DARK ENERGY SURVEY

#	Recommendations	Assigned to	Status/Action	Date*
4	Modify the calibration pipeline to output accessible QA prior to the survey start date.	Tucker, Petravick	The astrometric module (SCAMP) and the nightly photometric standards module (PSM) already output a variety of QA plots and log information. The main issue is making this QA more easily accessible to the collaboration. Our current thoughts are to post these automatically to a collaboration-accessible webpage. The mechanics of doing so are currently under discussion (26 June 2012). We intend to have a plan in place by August 31, and have the mechanism in place and tested by the start of DES operations. Update: these QA plots and logs are now output to the protected "desar" http/ftp file server as part of normal DESDM pipeline operations. Completed.	Plan: August 31, 2012 End date: December 10, 2012 March 2013

Calibration Responses to May 2012 Review: Sky Calibration Systems

DARK ENERGY SURVEY

#	Recommendations	Assigned to	Status/Action	Date*
7	Develop an agreed-to plan for the development, operations, and maintenance of the sky calibration systems.	Frieman, Kron, DePoy, Smith	A plan for RASICAM operations and maintenance, including roles and responsibilities, exists. A nominal plan for the GPS monitoring system, which should be very low-maintenance, has been discussed. A first draft of plans for operation and maintenance of other calibration systems (DECal and atmCam if deployed) exists and will be iterated. RASICAM: des-docdb 5532. DECal User's Manual: Docdb 6134. GPSMon has no user's manual yet. atmCam hasn't been permanently deployed.	Response transmitted Aug 10, 2012 March 2013.

Calibration Responses to March 2013 Review: 1.A.1. Number of Tilings Needed for Calibrations

DARK ENERGY SURVEY

#	Recommendations	Assigned to	Status/Action	Date*
1.A.1	Confirm that, given the DES strategy of 1 degree dithers of the hex centers between tilings, that a minimum of four tilings will result in a photometric calibration that meets the DES requirements. Then consider survey strategies that will achieve that in each survey year and evaluate the risk of not getting a complete calibration each year.	J. Annis, D. Tucker, S. Kent	Tests of the number of tilings needed to achieve DES photometric calibration requirements are currently being carried out both on simulations and on the SV data. Results should be available by mid-May 2013.	May 15, 2013

Calibration Responses to March 2013 Review: 1.A.2. Additional Calibration Data

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#	Recommendations	Assigned to	Status/Action	Date*
1.A.2	Consider taking extra calibration data, at least in the first year or two, to make sure that there is enough. For example, observations of dense stellar fields or many tilings of a small area dithered as with the DES observing plan.	D. Tucker, G.Bernstein, P. Martini, S. Kent, J. Annis	A detailed list of periodic and special-case calibrations for DES operations, initially generated in mid-2012 and refined during SV, exists in Section 4 of DES-doc#6584-v5 ("Plan for Calibration of the DES in the Early Years"). The general guiding principle (exercised within limits) is that it is better to take calibration data that are in the end not needed, than to skip calibration data only to discover later that they were needed. Annis, Bernstein, Kent, Martini, and Tucker will confer and sign off on the final version of this list by June 30, 2013.	June 30, 2013

Calibration Responses to March 2013 Review: 1.A.3. Extra Bad-Seeing Time for Calibrations

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#	Recommendations	Assigned to	Status/Action	Date*
1.A.3	Develop a metric for when repeated observations of the supernova fields provide diminishing returns and consider using that extra bad-seeing time for calibration or other supporting data.	J. Annis, M. Sako, D. Tucker	Discussions with the SN WG occurred at the April 2013 DES Collaboration Meeting and are ongoing. Extra bad-seeing time could possibly be used for taking additional standard star and star flat data if conditions are otherwise photometric (transparent). These studies will be completed and decision taken by end of May, 2013.	June 1, 2013

Calibration Responses to March 2013 Review: 1.H.1. Full Utilization of Calibration Systems

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#	Recommendations	Assigned to	Status/Action	Date*
1.H.1	The plan for making full utilization of the various calibration system data products should be completed by the end of the first survey season, and implemented prior to beginning of the second.	D. Tucker, D. DePoy, R. Kessler, W. Wester, S. Kent	This recommendation is based on the finding that, although the machinery for gathering the instrumental system response data (DECal) the atmospheric transmission data (GPS, prototype atmCam and RASICAM) are ready for DES Operations, the plan for using these data streams for DES calibrations is not yet fully fleshed out. The Oracle database schema for the DECal scans that will form the basis of the interface with DESDM has been tested and is described in DES-doc#6332; this schema is also extendable to the data streams from the atmospheric transmission monitors. A draft plan for using these data streams for improved calibration of the coadds is given in DES-doc#5704. A small task group will be formed to further flesh out the plans for using these data streams for both the wide-field survey and the SN survey; plan will be finalized by February 28, 2014 (end of the first season of operations), and implemented by September 1, 2014 (beginning of the second season of operations). As we learn more over the course of the survey, details of implementation for some of these systems may evolve.	Plan: Feb 28, 2014 Implementation: Sep 1, 2014

Calibration Responses to March 2013 Review: 1.H.2. Dealing With Discrete Changes in System

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#	Recommendations	Assigned to	Status/Action	Date*
1.H.2	The plan for dealing with discrete changes in the telescope/camera system should be formalized prior to beginning operations.	D. Tucker, S. Kent, H. T. Diehl, G. Bernstein, J. Annis	A draft list of calibration procedures for dealing with discrete changes in the telescope/camera system (e.g., replacing a CCD or a filter) exists in Section 4.5 of DES-doc#6584-v5 ("Plan for Calibration of the DES in the Early Years"). Annis, Bernstein, Diehl, Kent, and Tucker will confer and sign off on the final version of this list by June 30, 2013.	June 30, 2013

Calibration Responses to March 2013 Review: 1.H.3. PreCam

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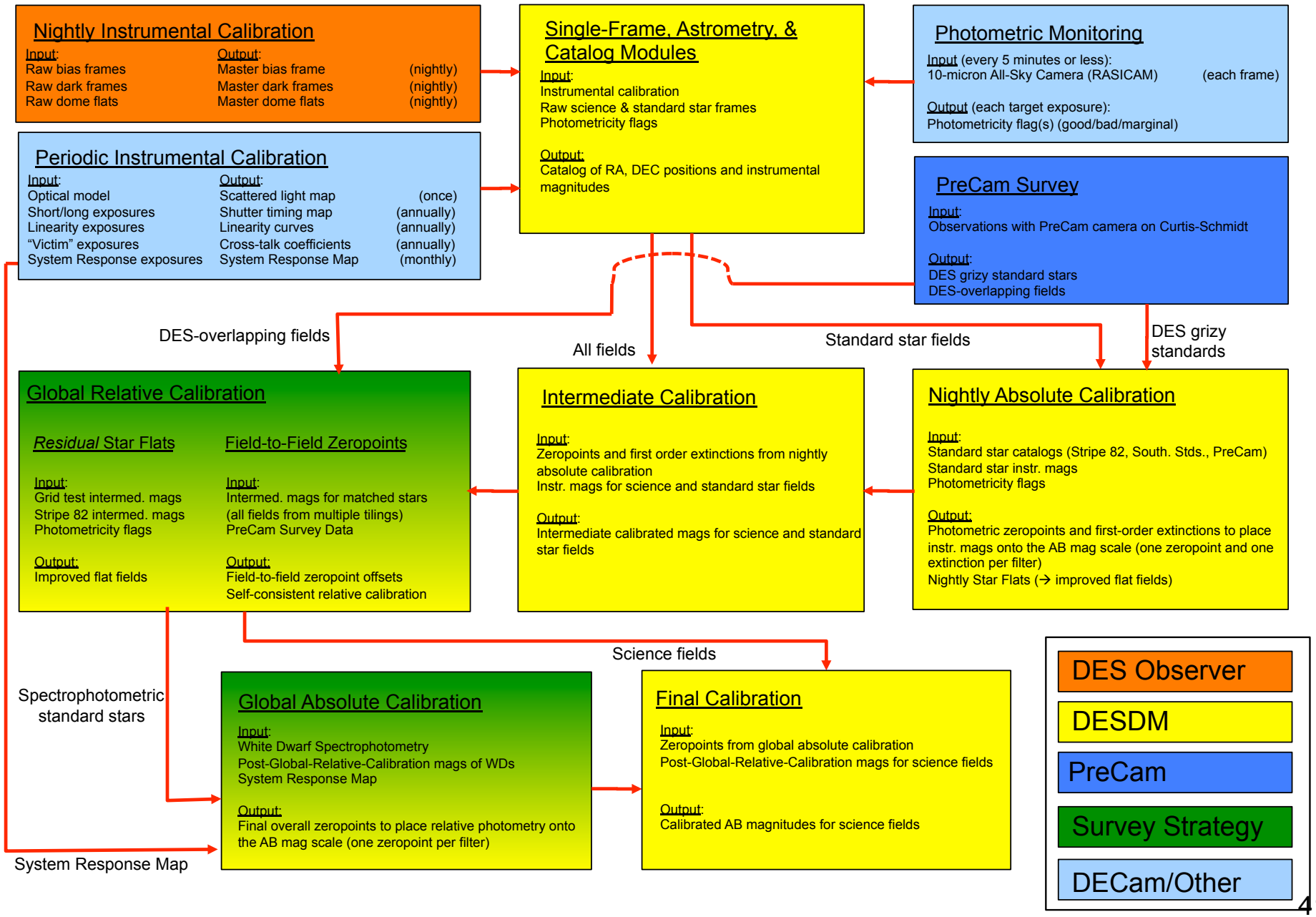
#	Recommendations	Assigned to	Status/Action	Date*
1.H.3	Completion of the PreCam program should be vigorously pursued, and if possible completed prior to the beginning of the second year of operations.	D. Burke, S. Kuhlman, D. DePoy	The calibration working group will complete analyses of the existing PRECAM 1.0 data combined with DES SV data as they are processed by the DESDM pipelines. These analyses will incorporate available data from other calibration standard sources. The results of these analyses will be used to evaluate our ability to use the PreCam network of standard stars to achieve the science requirements for reproducibility and uniformity of DES photometry, the impact of the PreCAM network on DES operations efficiency, and the need for additional acquisition of spectroscopy and/or imaging of other stadard objects (e.g. white dwarf stars) for calibration of DES color zero points. These analyses will be completed in time to allow necessary observing to be carried out during the first season (2013-2014) of the DES Campaign.	Aug. 1, 2013

DES Photometric Calibrations Flow Diagram (v4.1)



Filter Uniformity Spec's

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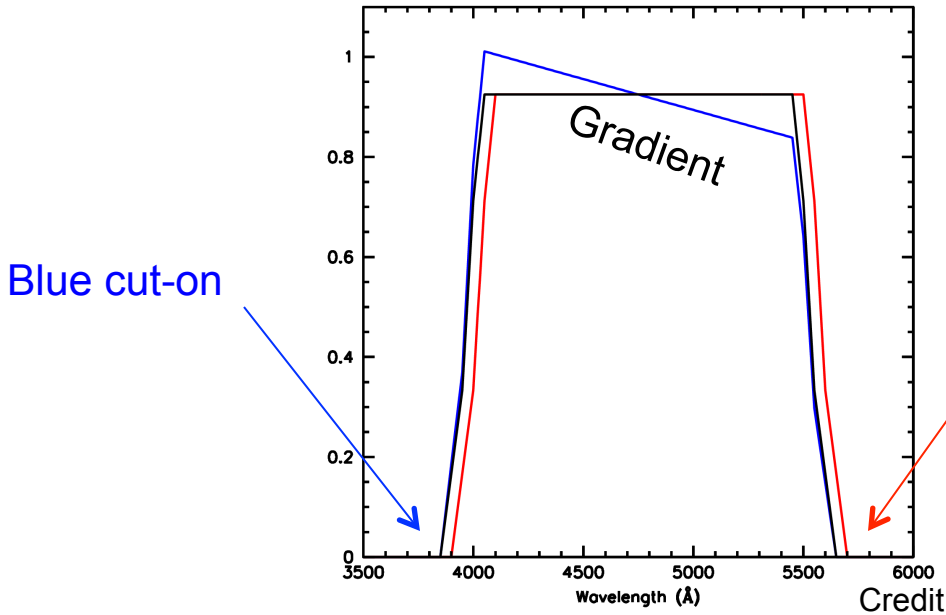
Table 4: Uniformity specifications for DES filters (difference between area-weighted transmission curve and any 70 mm diameter spot on filter)

Filter	Blue cut-on wavelength (nm)	Red cut-off wavelength (nm)	Allowable gradient in transmission curve	Notes
DES g	±2	±2	±5%	See 3.2.5.c
DES r	±3	±3	±7%	See 3.2.5.c
DES i	±3	±4	±5%	
DES z	±4	±5	±9%	
DES y	±5	Not applicable	±9%	

Credit: D. DePoy



Black curve is reference.

Credit: H. Lin

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4. Nightly/Intermediate Calibrations: The Photometric Equation

- The Photometric Equation is a simple model that fits the observed magnitudes of a set of standard stars to their "true" magnitudes via a simple model; e.g.:

$$m_{inst} - m_{std} = a_n + kX \qquad (1)$$

  - m_{inst} is the instrumental magnitude, $m_{inst} = -2.5log(counts/sec)$ (input)
  - m_{std} is the standard ("true") magnitude of the standard star (input)
  - a_n is the photometric zeropoint for CCD n (n = 1-62) (output)
  - k is the first-order extinction (input/output)
  - X is the airmass (input)

- A refinement: add an instrumental color term for each CCD to account for small differences between the standard star system and the natural system of that CCD:

$$m_{inst} - m_{std} = a_n + b_n \times (stdColor - stdColor_0) + kX \qquad (2)$$

  - b_n is the instrumental color term coefficient for CCD n (n = 1-62) (input/output)
  - $stdColor$ is a color index, e.g., $(g-r)$ (input)
  - $stdColor_0$ is a constant (a fixed reference value for that passband) (input)
  - DES calibrations will be in the DECam natural system, but there may be variations from CCD to CCD within the DECam focal plane or over time.

From the Scientific Requirements Document
(sciReq-9.86, 10 June 2010)

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R-10 For each of the *grizY* bandpasses of the wide-area survey, the fluctuations in the spatially varying systematic component of the magnitude error in the final co-added catalog must be smaller than 2% rms over scales from 0.05 to 4 degrees.

Internal (Relative) Calibration

$m_i = -2.5\log(f_{i1}/f_{i2}) + C$

R-11 The color zeropoints between the survey fiducial bandpasses (*g-r, r-i, i-z*) must be known to 0.5% rms. The *z-Y* color zeropoint shall be known to 1% rms.

Absolute Color Calibration

$m_i - m_z = -2.5\log(f_i/f_z) + zp_{iz}$

R-12 The i-band magnitude zeropoint relative to BD+17, and therefore the AB system, must be known to 0.5% rms.

Absolute Flux Calibration

$m_i = -2.5\log(f_i) + zp_i$

R-13 The system response curves (CCD + filter + lenses + mirror + atmosphere at 1.2 airmasses) must be known with sufficient precision that the synthesized *grizY* magnitudes of any astronomical object with a calibrated spectrum agree with the measured magnitudes to within 2%. When averaged over 100 calibrating objects randomly distributed over the focal plane, the residuals in magnitudes due to uncertain system response curves should be < 0.5% rms.

System Response

G-4 A goal of the survey is to achieve **R-10** at the enhanced level of 1% for the final co-added catalog.

G-5 A goal of the survey is to achieve **R-10** over 160 degrees of Right Ascension and 30 degrees of Declination.